Progress of the 1/12° Global HYCOM Effort

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1/12° Global HYCOM: Initial Development and Evaluation

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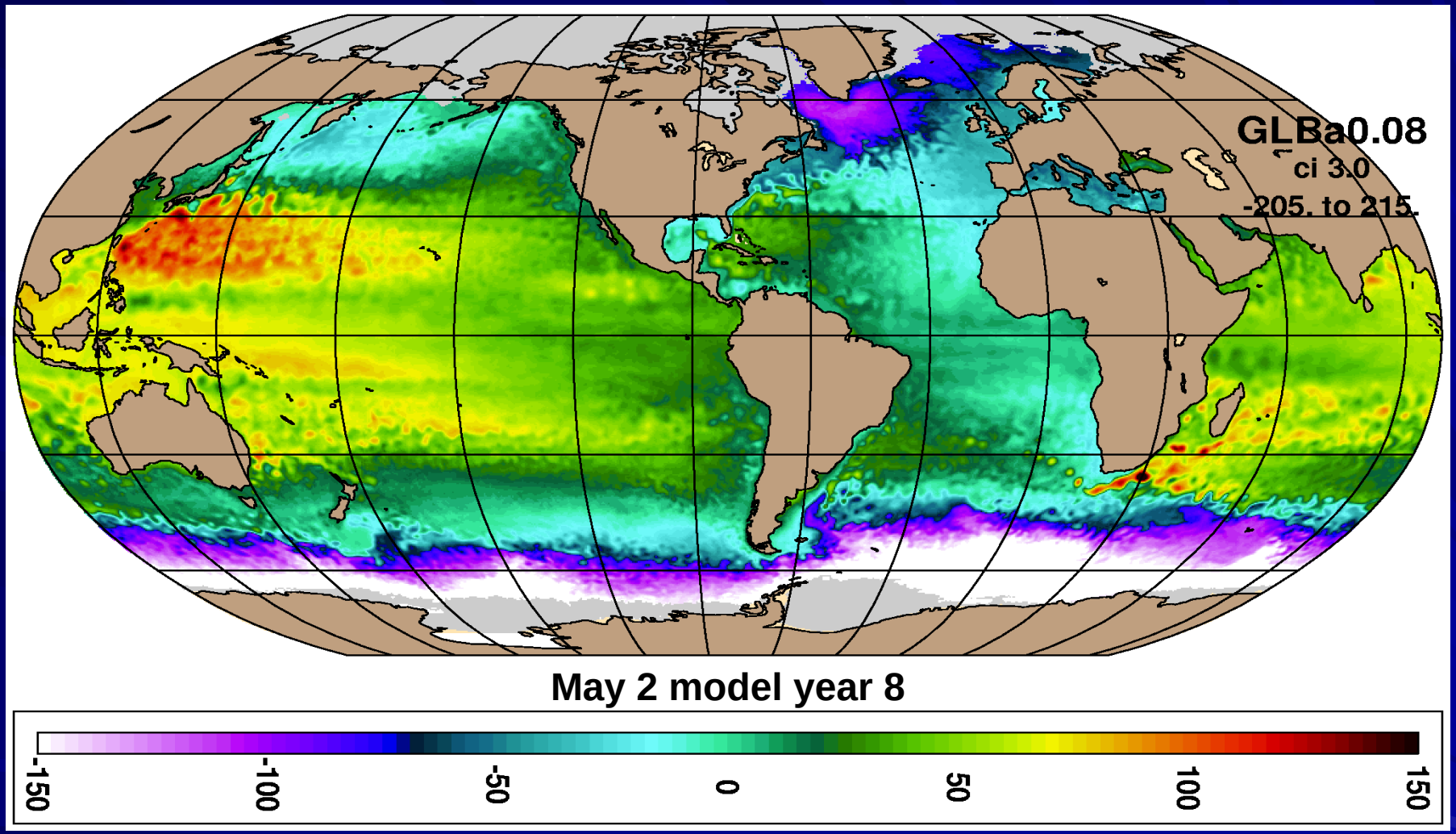
HYCOM Long-term Goals for Operational Ocean Prediction

- 1/12° fully global ocean prediction system transitioned to NAVO in 2007
  - Include shallow water, minimum depth 5 m
  - Coupled sea-ice model (LANL CICE)
- Increase to 1/25° resolution globally by the end of the decade
  - Optimal resolution for basin-scale
  - Boundary conditions for coastal models

Global HYCOM Configuration

- Horizontal grid: 1/12° equatorial resolution
  - 4500 x 3298 grid points, 6.5 km spacing on average, 3.5 km at pole
- Mercator 79°S to 47°N, then Arctic dipole patch
- Vertical coordinate surfaces: 26-28 for σ_0, 32 for σ_2*
- KPP and GISS mixed layer models
- Thermodynamic (energy loan) sea-ice model
- Surface forcing: wind stress, wind speed, thermal forcing, precipitation, relaxation to climatological SSS
- Monthly river runoff (986 rivers)
- Initialize from January climatology (GDEM3) T and S, then SSS relaxation from PHC 3.0
  - No subsurface relaxation to climatology

1/12° Global HYCOM snapshot: SSH and ice (gray)



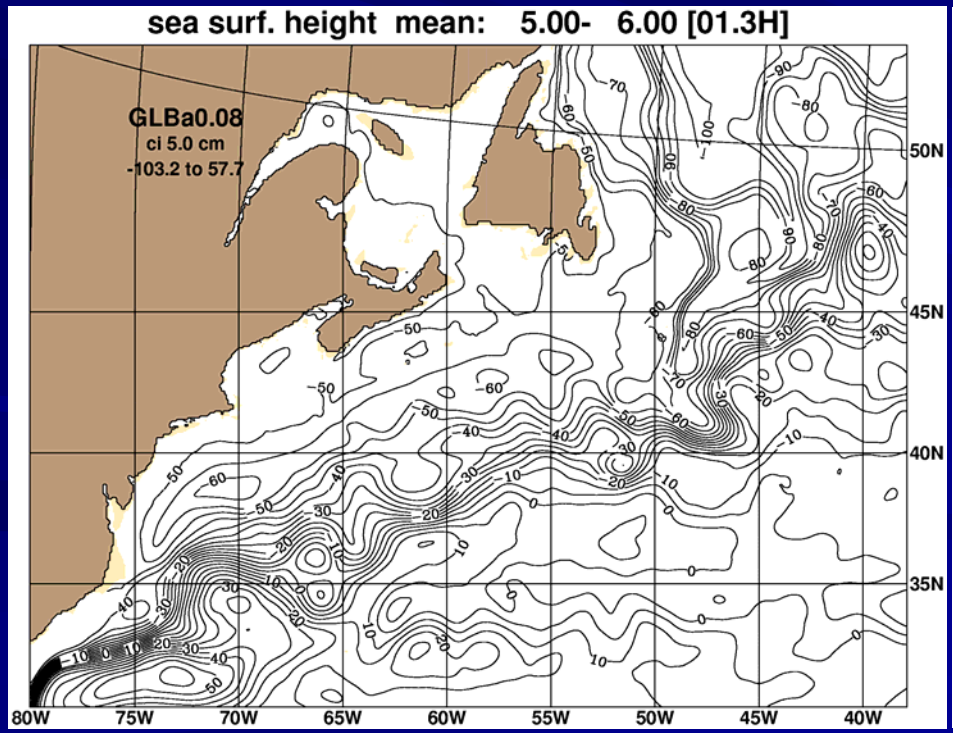
- Running at NAVO under DoD Challenge
- 190K CPU hrs/model year on 784 CPUs
- 7.2 TB/model year for daily 3-D output

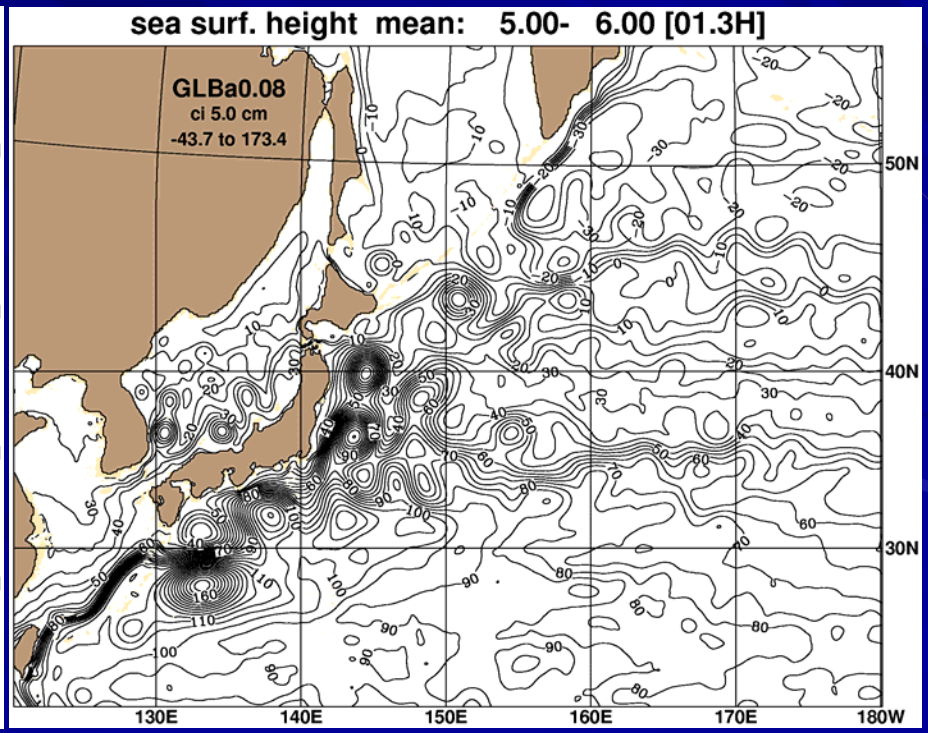
1/12° Global HYCOM Experiments

- ECMWF Reanalysis (ERA15) climatological wind and thermal forcing
  - Annual bias corrections to air temperature (ERA40), radiative fluxes (ISCCP) and precipitation (GPCP)
- σ_0 simulations:
  - 26-layers with KPP for 6 model years
  - 28-layers with GISS for 3 model years
- σ_2* simulations:
  - 32-layers with GISS for 9 model years

Initial 1/12° Global HYCOM σ_0 Simulation

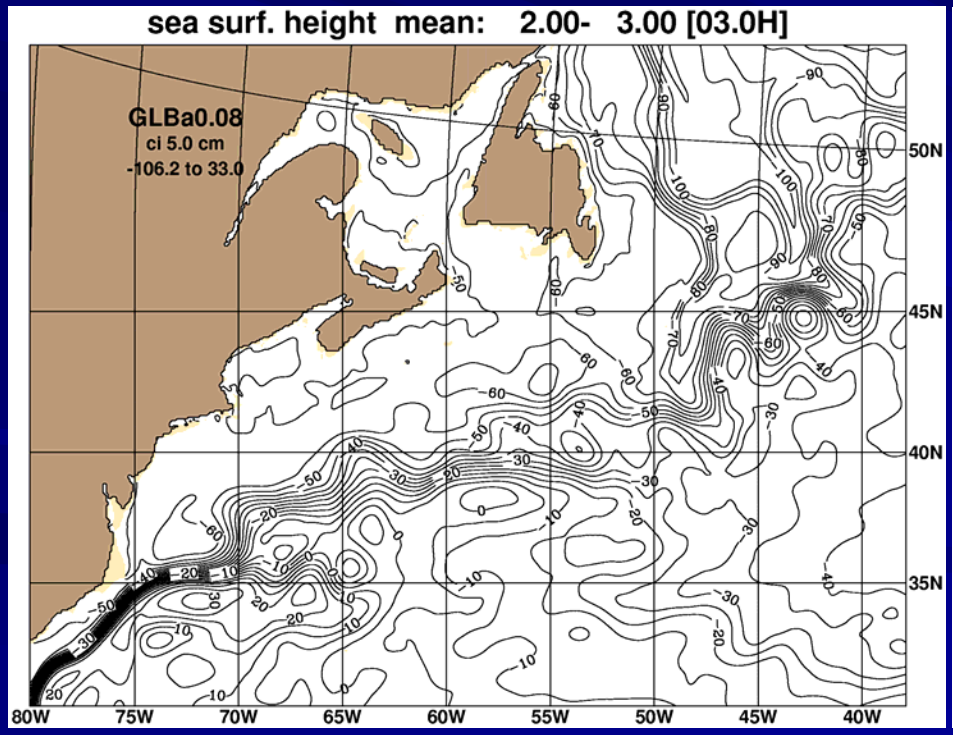
- Major shortcomings:
  - Poor simulation of both Gulf Stream and Kuroshio
  - Poor representation of tropical current systems
  - Unrealistic transport at key locations:
    - Florida Straits (23 Sv vs. ~32 Sv) [simulated vs. observed]
    - Drake Passage (91 Sv vs. ~134 Sv)
    - Pacific to Indian Ocean Throughflow (22 Sv vs. ~10 Sv)

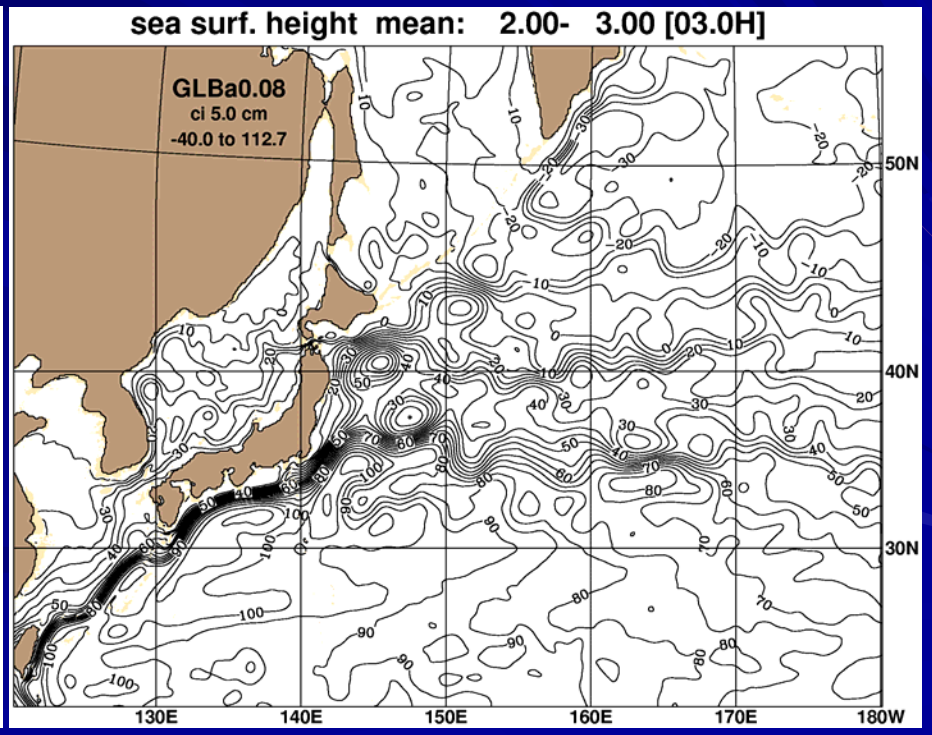




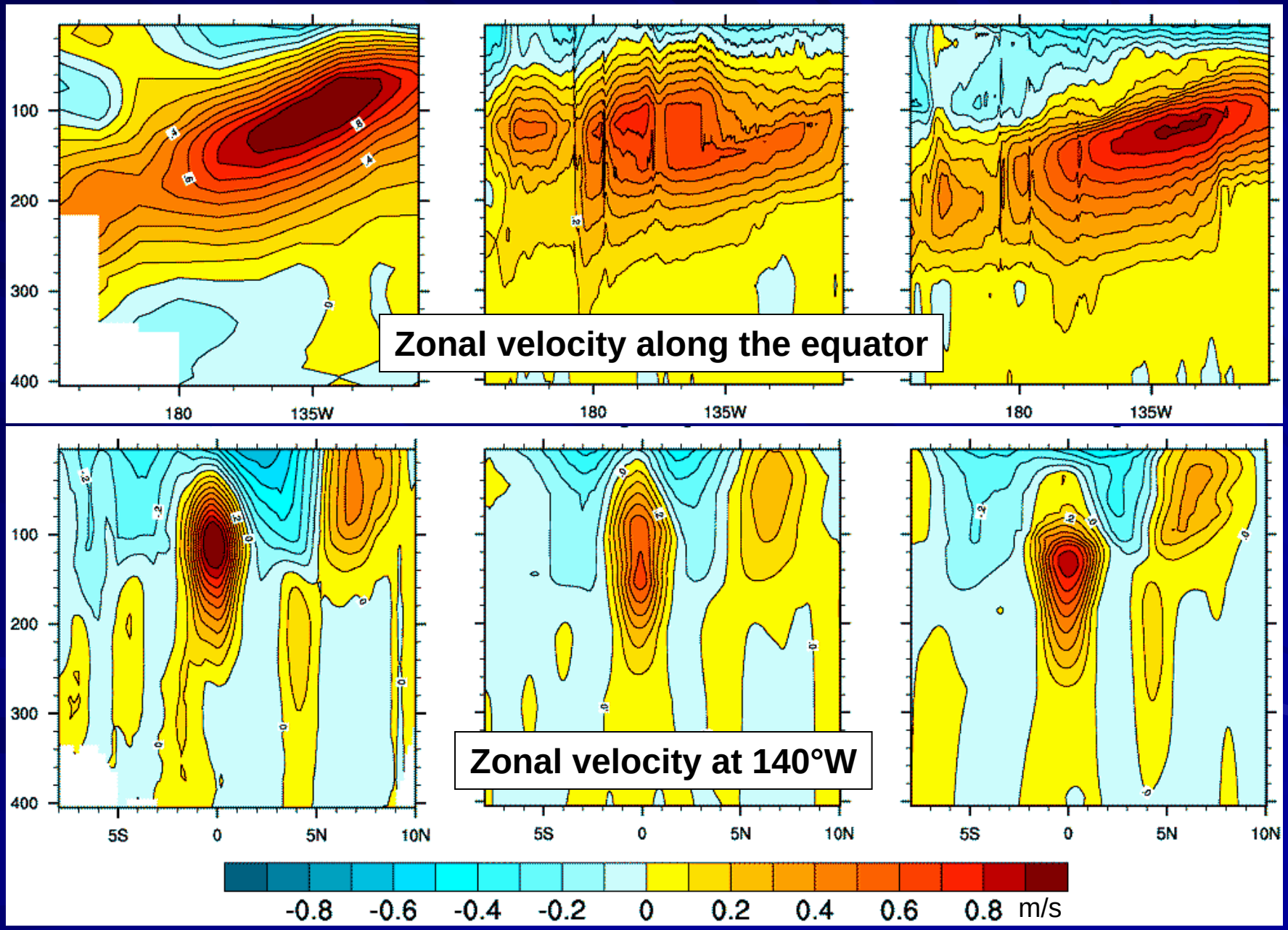
Improved 1/12° Global HYCOM σ_0 Simulation

- Modifications
  - Added two layers (26 → 28) and changed layer structure
  - Increased eddy viscosity: A = 30 m^2/s constant everywhere
  - Increased Smagorinsky diffusion: .05 → .1
  - KPP → GISS

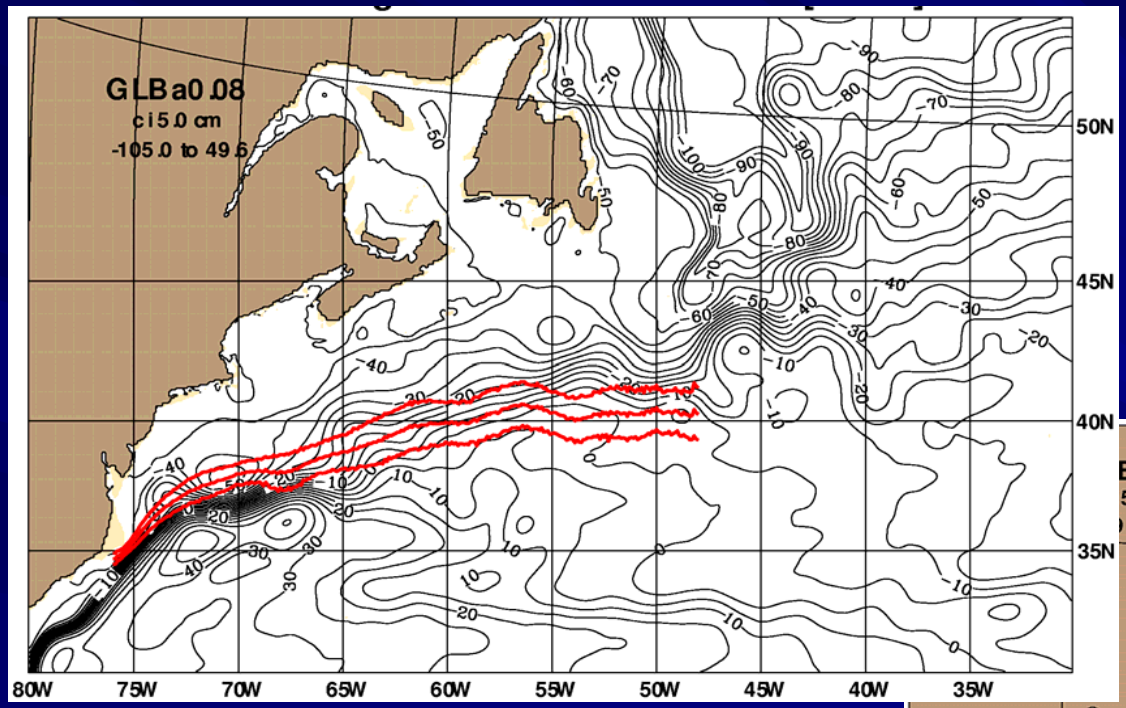




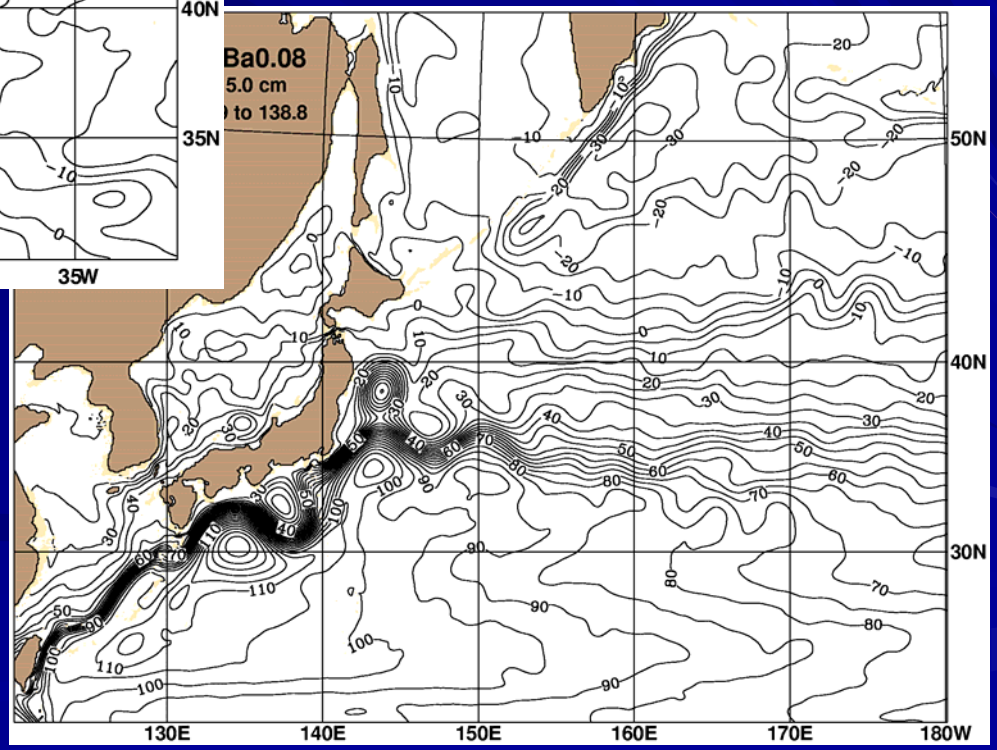
Improvements in Tropical Pacific Current Structure



1/12° Global HYCOM Mean Gulf Stream And Kuroshio Pathways



Latest σ_2* simulation



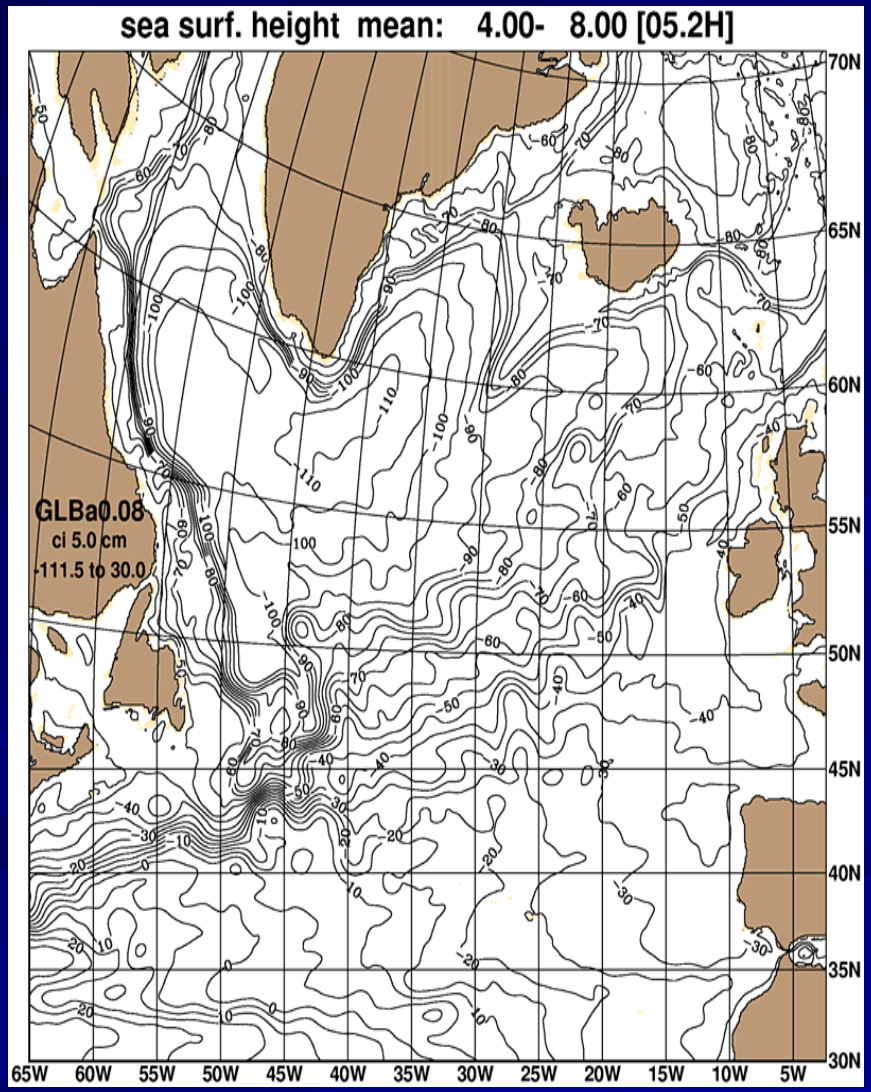
Mean over four model years

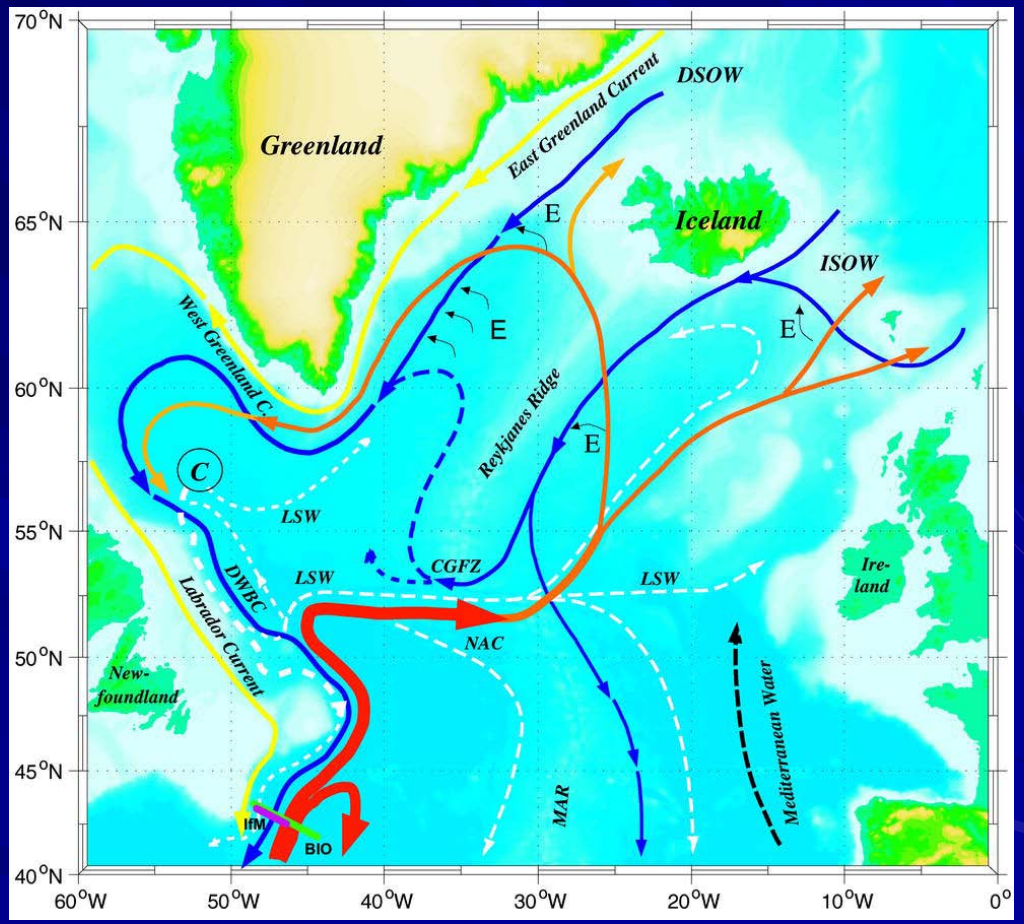
ERA15 climatological wind & thermal forcing

6 Dec 2005

1/12° Global HYCOM σ_2* Simulation

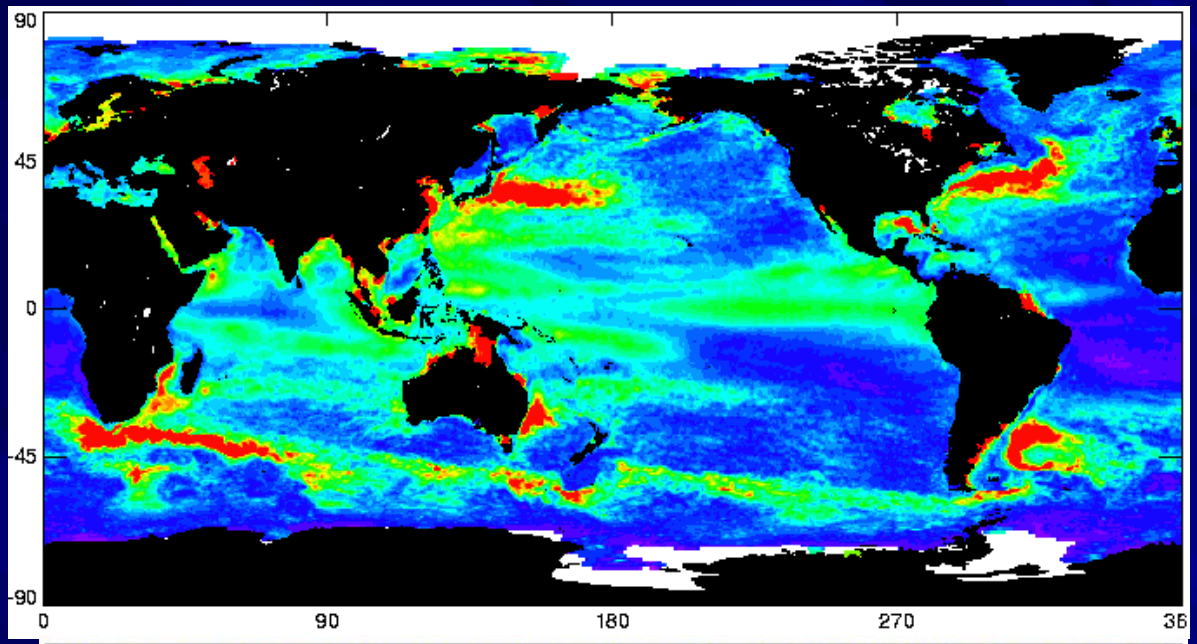
The Atlantic subpolar gyre generally looks good



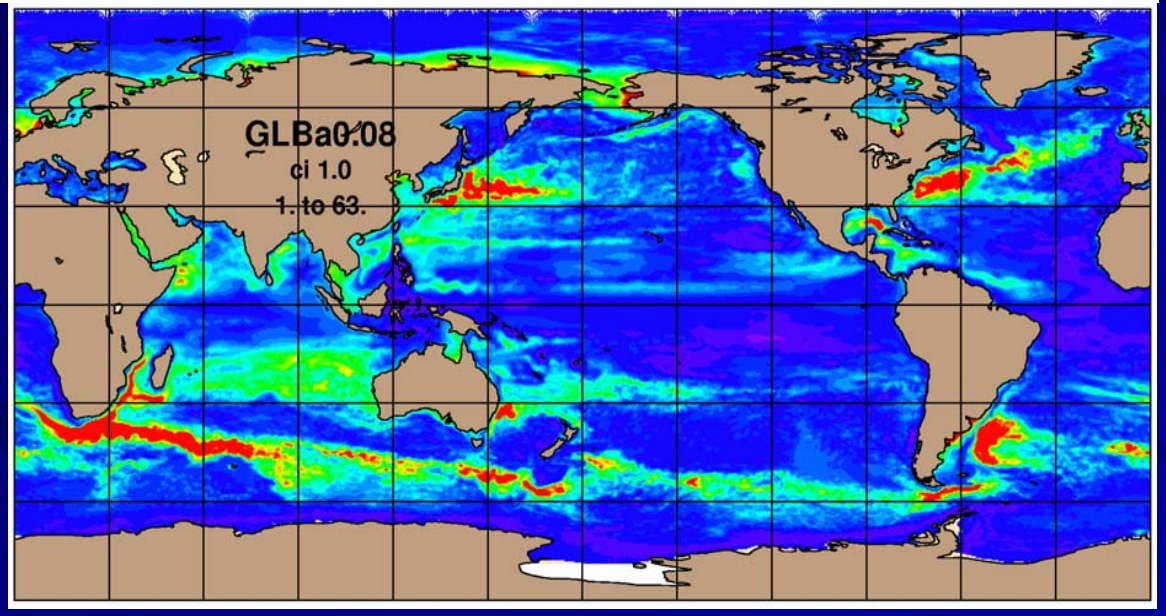


From Schott et al. (2004, JPO)

Global SSH Variability



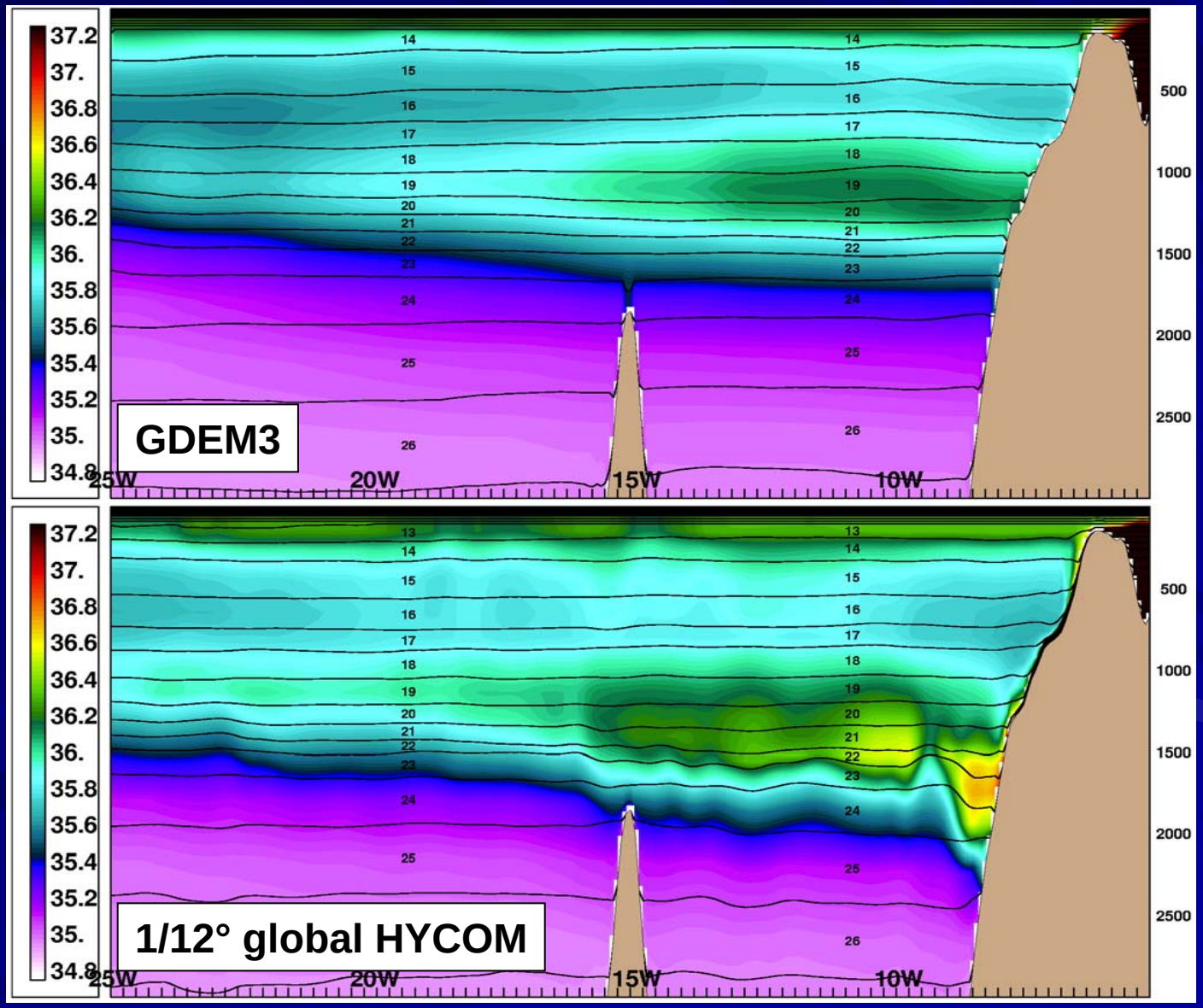
Oct 92 – Nov 98 SSH variability based on T/P, ERS-1 and ERS-2 altimeters (from Collecte, Localisation, Satellites (CLS))



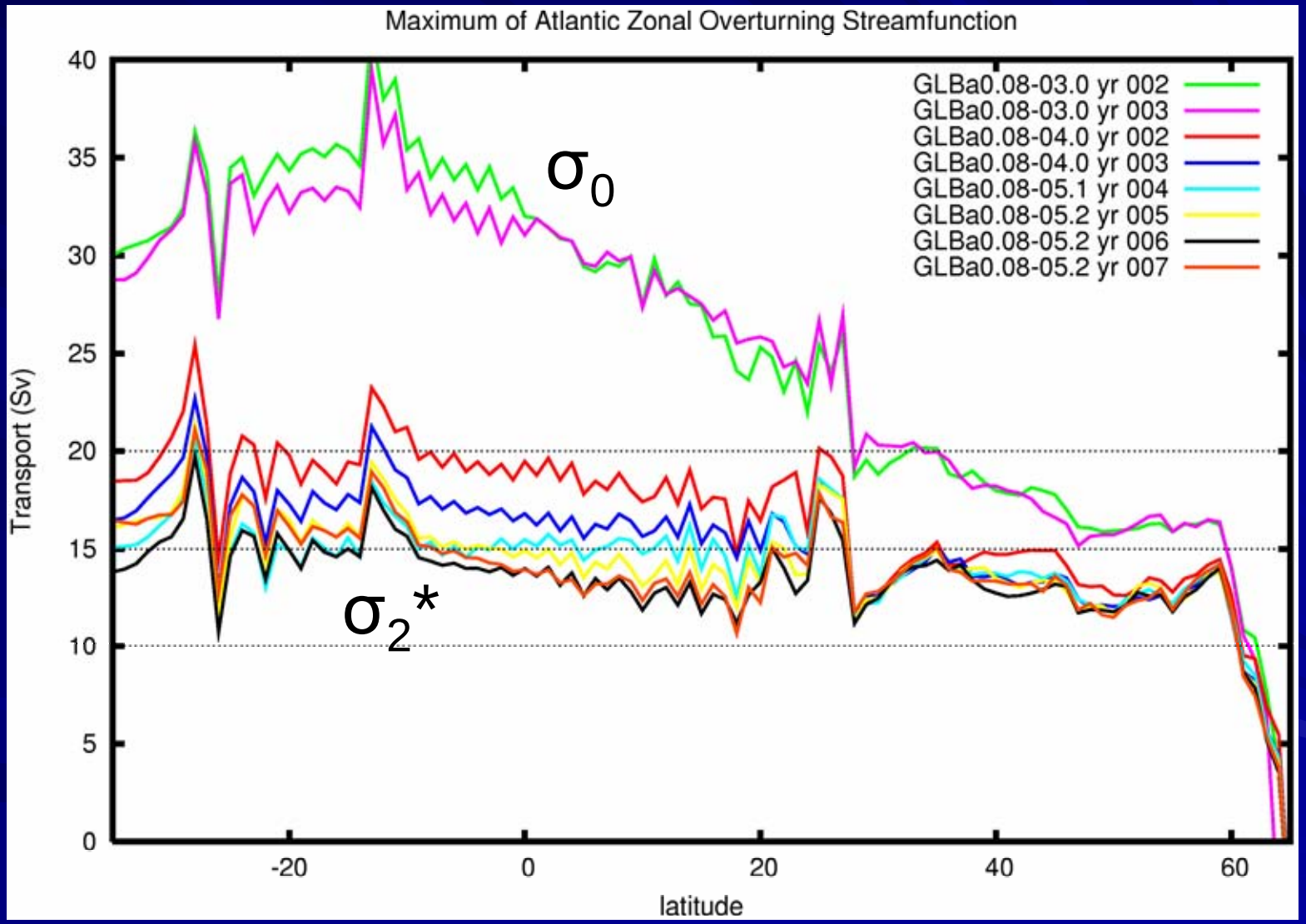
SSH variability from 1/12° global HYCOM σ_2* with climatological wind and thermal forcing

Mediterranean Sea Outflow

Salinity section at 36°N



Atlantic Meridional Overturning Circulation
σ_0 vs. σ_2*



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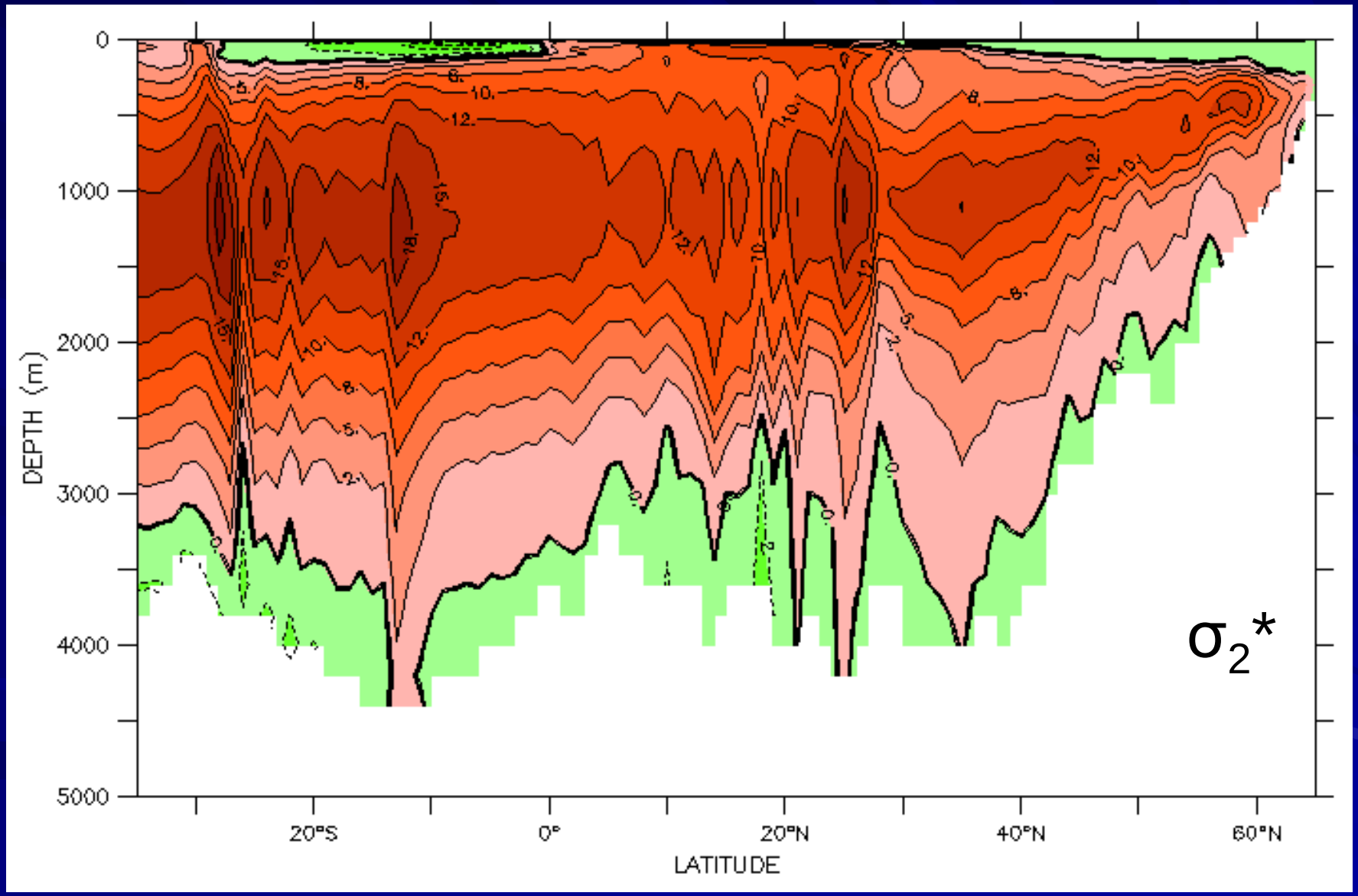
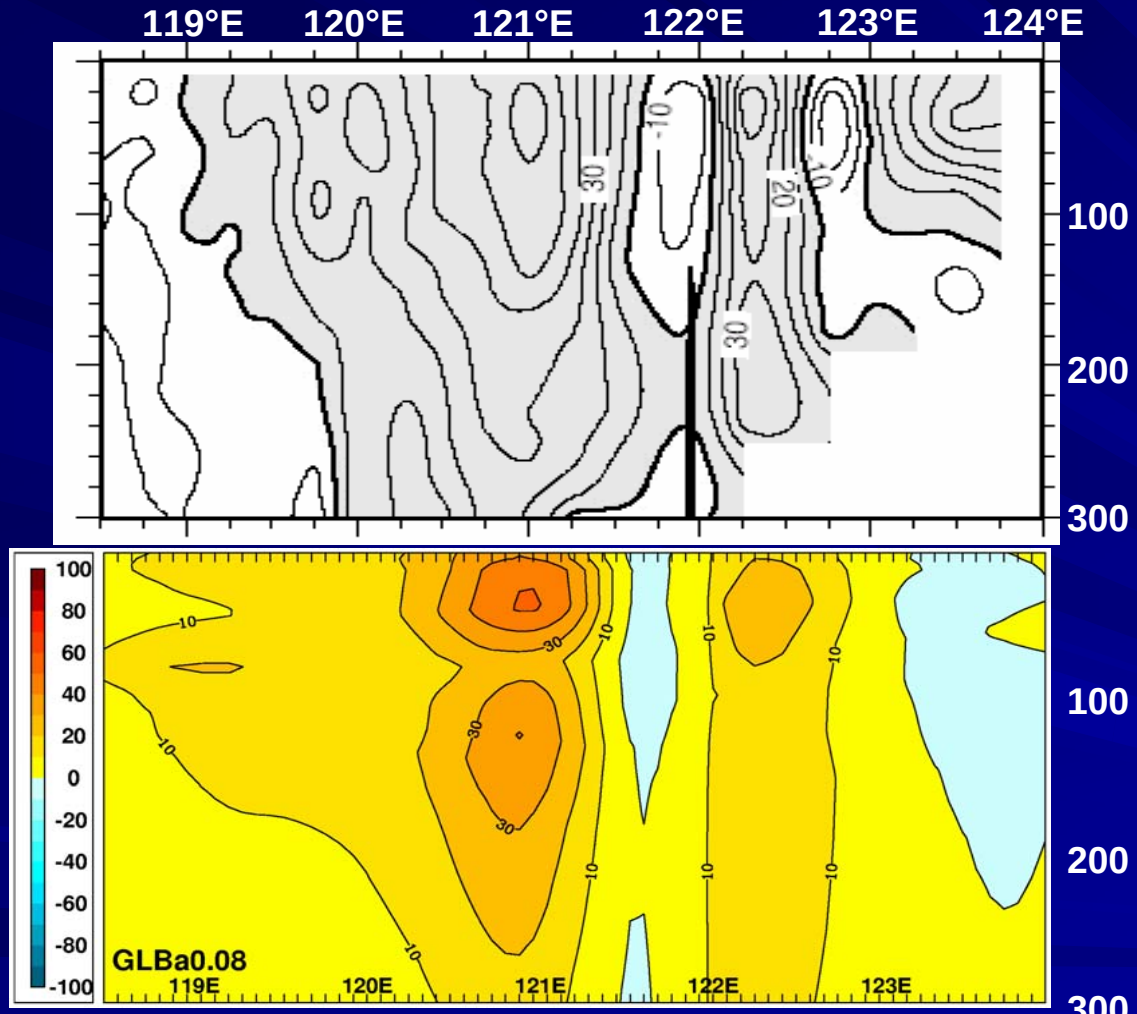
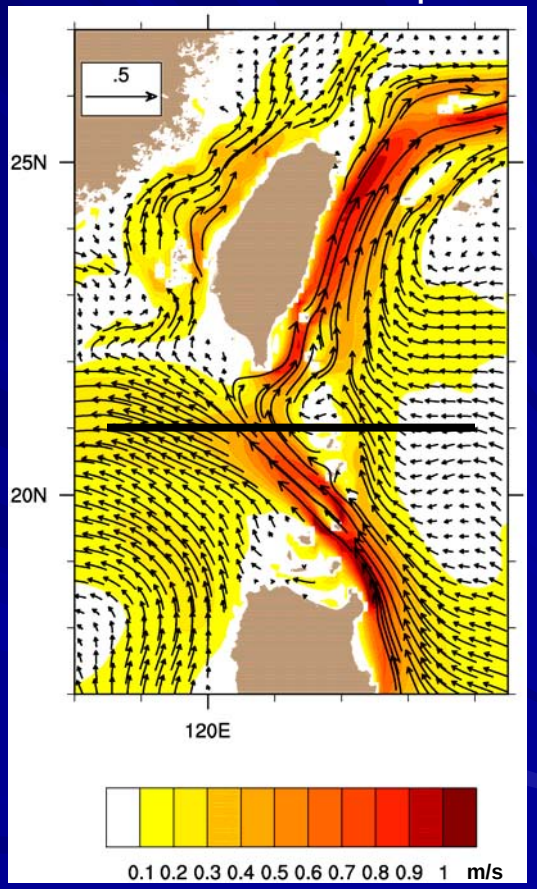


Velocity Cross-section Along Luzon Strait

Sb-ADCP data (top) vs. 1/12° global HYCOM (bottom) in the upper 300 m
Section along 21°N between 118.5°E and 124.0°E



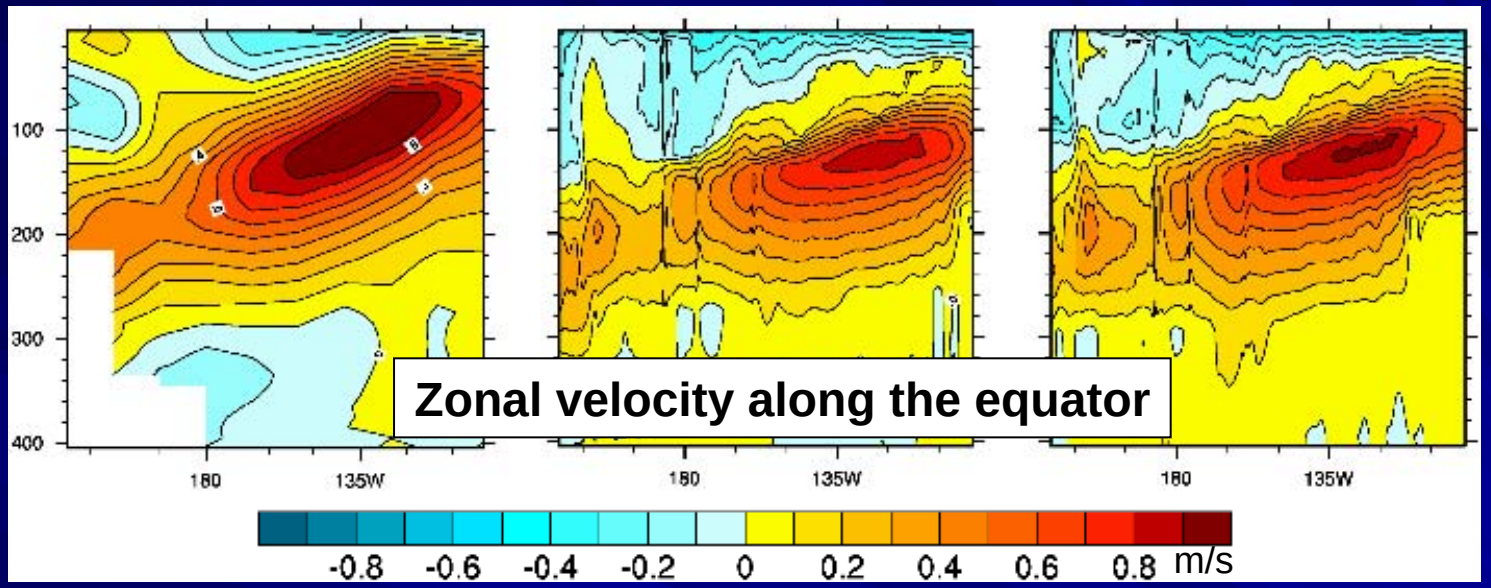
Cross-section overlaid on mean currents and speed

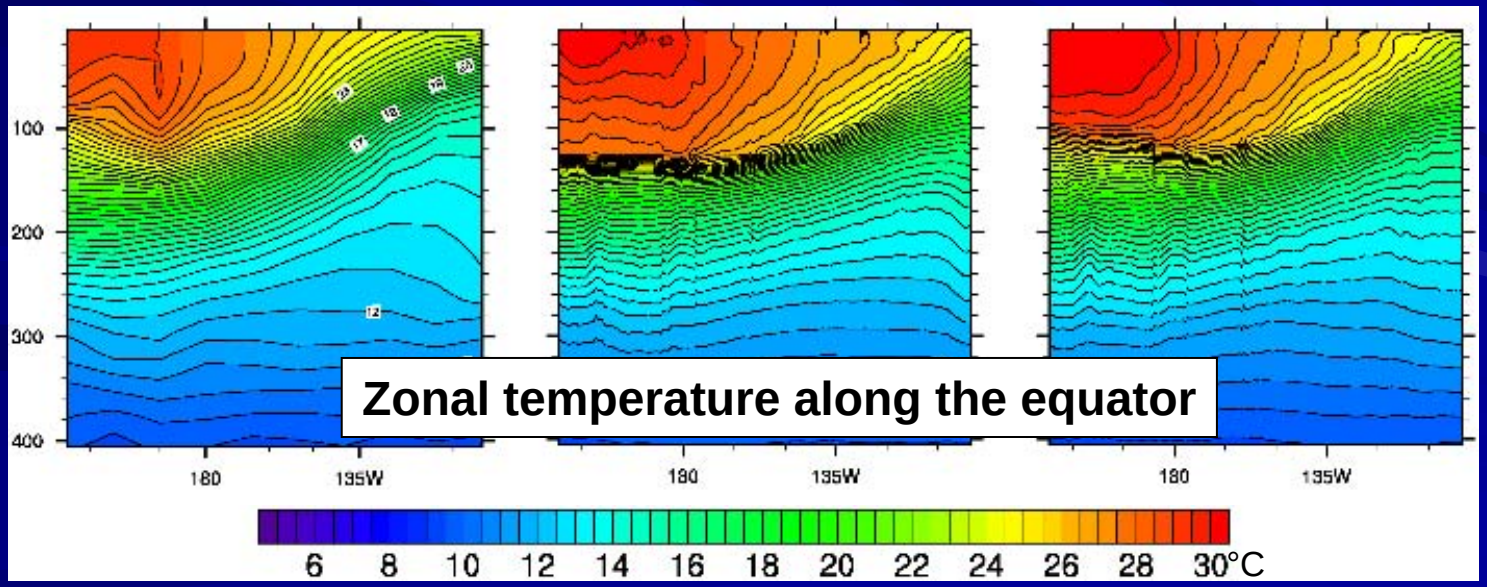


Sb-ADCP data from Liang et al. (2003, DSR Pt. II)
Mean from HYCOM with ERA15 wind and thermal forcing
No ocean data assimilation in HYCOM

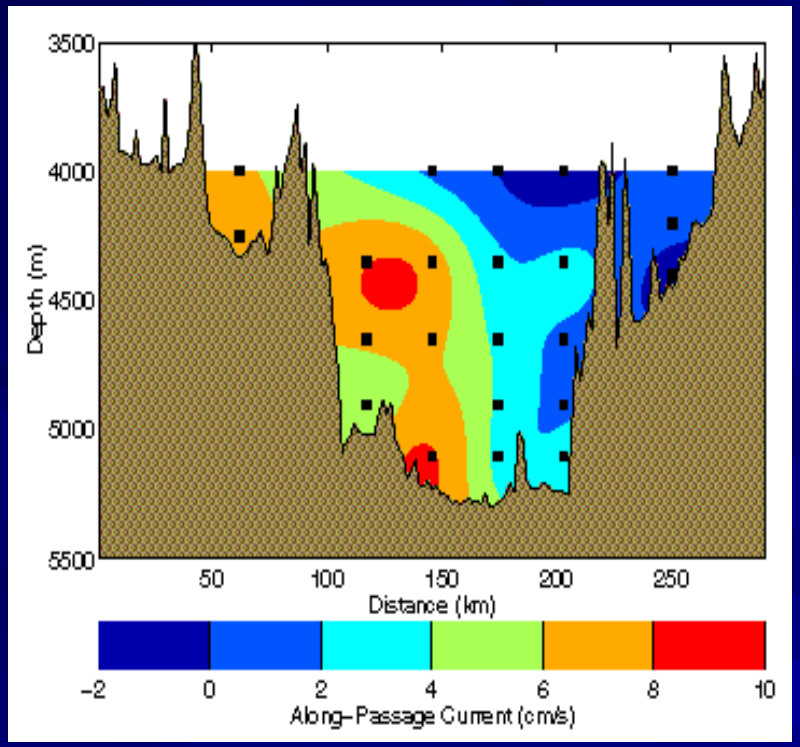
Vertical Structure in the Equatorial Pacific

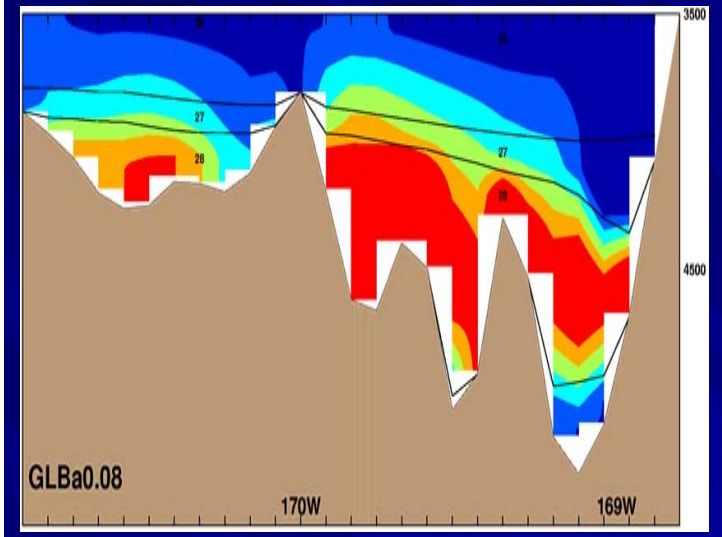
Observations **32-layer σ_2*** **Modified 28-layer σ_0**

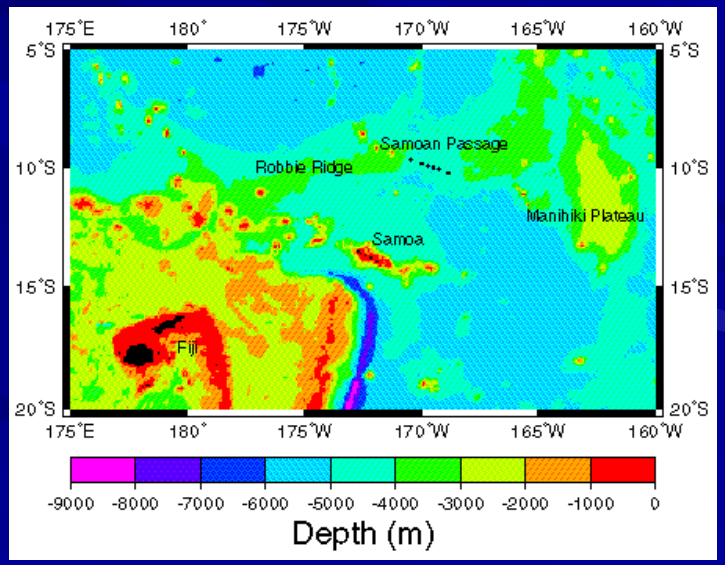




Deep Flow Through Samoan Passage







Observed mean northward transport below 4000 m = 6.0 Sv
Rudnick (1997,JGR)

HYCOM σ_2* in layers 27-32 = 9.3 Sv

Transport Comparisons at Key Locations

Section	Obs.	Orig. σ_0	Mod. σ_0	Orig. σ_2*	Mod. σ_2*
PCM-1	23	24.8	24.7	25.5	26.4
Bering Strait	1	1.1	1.1	1.1	1.1
PACIO TF	-10	-21.8	-24.1	-18.2	-17.0
STACS	30-34	23.2	23.1	22.9	24.0
Yucatan Channel	23-27	23.3	21.6	21.8	22.0
Denmark Strait	-2.9	-2.9	-2.3	-2.3	-2.9
Drake Passage	134	91.3	96.2	152.4	146.4

Modified σ_2* experiment uses a new topography with sill depth refinements in the IAS, Indonesian Seas, etc.

Future Work (FY06)

- Ten May 2001 – June 2002 assimilative runs in FY06
  - Time period with three satellite altimeters
  - Five with bi-weekly 30-day forecasts
- Near real-time nowcast/forecast starting in mid-FY06
- Interannual non-assimilative case:
  - 1995-present using NOGAPS
- Coupling with LANL CICE via ESMF